Porgy Documentation

Release 0.2

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October 25, 2011

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PORGY is an interactive visual environment for modelling complex systems through graphs and graph rewriting rules. Graph rewriting systems appear as a powerful formalism to capture and study phenomena occurring in complex systems, such as the evolution of bio-molecular networks, adhoc communication networks or interaction nets.

Contents:

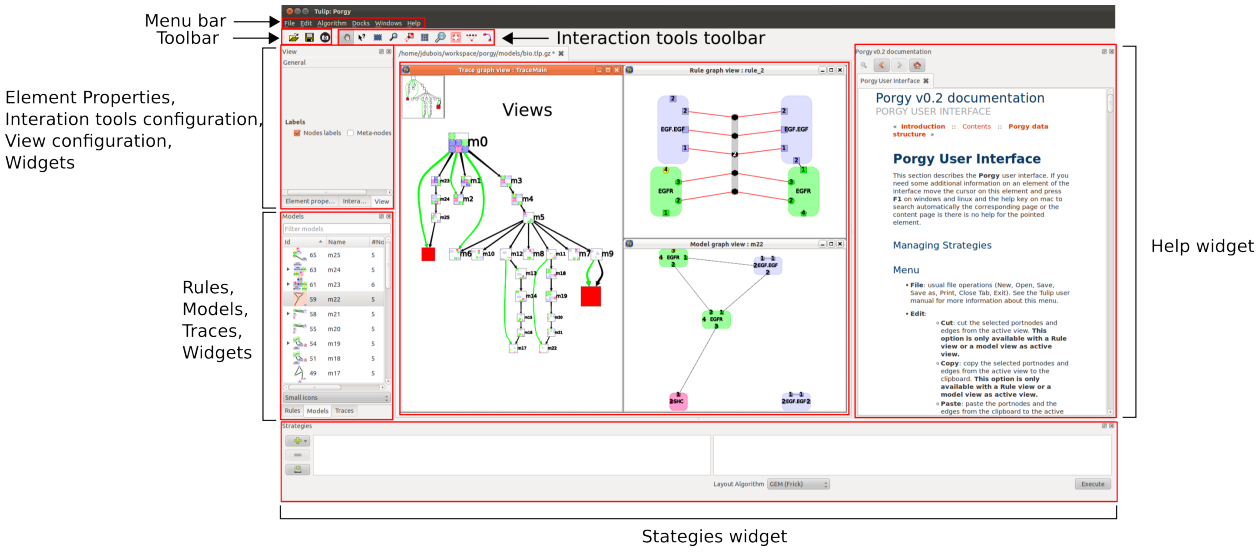
CHAPTER

ONE

PORGY USER INTERFACE

This section describes the **Porgy** user interface. If you need some additional information on an element move the cursor on it and press **F1** on windows and Linux and the help key on mac to get it's help page.

1.1 Overview



1.2 Menu

- **File**: usual file operations (New, Open, Save, Save as, Print, Close Tab, Exit). See the Tulip user manual for more information about this menu.
- **Edit:**
  - **Cut**: cut the selected portnodes and edges from the active view. **This option is only available if the active view is a Rule view or a model view.**
  - **Copy**: copy the selected portnodes and edges from the active view to the clipboard. **This option is only available if the active view is a Rule view or a model view.**
  - **Paste**: paste the portnodes and the edges from the clipboard to the active rule view. **This option is only available if the active view is a Rule view or a model view.**

  - **Select all**: clear the selection then add the portnodes and the edges present in the active view.
  - **Deselect all**: clear the selection.
  - **Invert selection**: invert the selection. Selected elements become unselected and unselected become selected.
  - **Delete selection**: delete portnodes and edges selected in the active view. **This option is only available if the active view is a Rule view or a model view.**
- **Algorithm: allows the user to compute and apply algorithm.**
  - **Measure**: compute and assign a value to the 'viewMetric' property of graph elements. For example, when running the 'Portnode's degree' algorithm, the degree (the number of neighbors) is computed and stored, for each portnode, into its 'viewMetric' property.
  - **Selection**: selects nodes and/or edges based on advanced criteria. (Selecting means assigning the 'viewSelection' property).
  - **General**: contains all the base porgy algorithms. This menu is made for an advance use of Porgy.
- **Docks**: allows to show and hide dock widgets in the Porgy user interface.
- **Windows**: manages the sub-windows of the view window.
- **Help**: Tulip documentation, Preferences, Plug-ins manager, About this software, including version number.

1.3 Toolbars

1.3.1 Generic options toolbar

The toolbar contains 3 icons:

- Open file: Open a new graph.
- Save file: Save the current graph.
- Snapshot : Take a snapshot of the current view.

1.3.2 Current view interaction tools toolbar

The toolbar contains all the interaction tools available for the activated view. For more information about each tool see the documentation of the views.

1.4 Configuring current view

Click the "View" tab at the top left corner to access this sub-window. Here one can configure the views. Thus, when the type of active view changes, this window also changes. Each view has it's own configuration widget see, the documentation of the views if you want more information about a specific configuration widget.

1.5 Configuring Current Interaction Tool

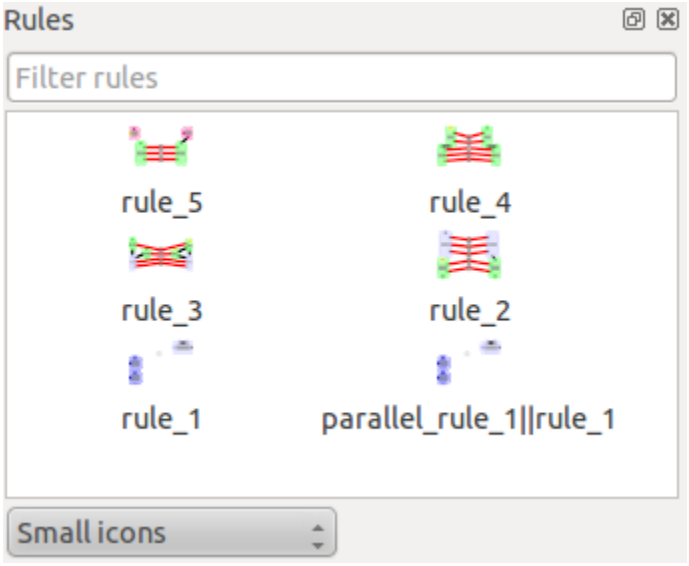
Click the "Interactor" tab at the top left corner to access this sub-window. Here one can configure and the active interaction tool. Thus, when the current interaction tool changes, this window also changes. Each interaction tool has it's own configuration widget, see the documentation of the views if you want more information about a specific configuration widget.

1.6 Configuring Element Properties

Click this button in the toolbar , then click an element (node or edge). The element tab opens:

Like before, double-click a cell (in the value column) to update it.

1.7 Editing Rules



Click on **Rules** tab to access to the Rules management widget. Here one can create, visualize and destruct rules. Use the text line at the top of the widget to filter rules using rule names.

There is four preview mode :

- **List**: Do not display rules previews
- **Small icons**
- **Medium icons**
- **Large icons**

To display a larger preview of the rule hoover it.

1.7.1 Contextual menu

- **Show** : A rule must be selected to enable this action. Displays a visualization/edition view for the selected rule. One can also double click on the rule or drag and drop the view on the workspace to display it.
- **Create new** : Create a new empty rule.
- **Clone** : A rule must be selected to enable this action. Clone the selected rule, i.e create a copy of the rule with the same port nodes and the same values.
- **Delete** : A rule must be selected to enable this action. Delete the rule.If the rule is used in an existing model it cannot be deleted.

1.7.2 Applying a rule

The application of a rule is made by a drag and drop of a rule to:

- a model metanode in the trace view. If the operation is valid a green square will appear on the model.
- a model view.

Once you drop the rule a parameter configuration widget will appear to configure the rule application.

You can customize these parameters:

- **Rule Name**
- **Maximum number of instances to apply**: the maximum number of matching to compute.
- **Use position?**: enable the **Position** parameter to restrict the search of the instances. See the **Position** parameter for more information.
- **Position**: the boolean property that define a subgraph of the model. This subgraph is used to restrict the search of the instances of the left-hand side rl of the rule to apply in the target model m. When one tries to find the instances I of rl in m, at least one node of each I must be in P. It is possible to define more than one P.
- **Layout algorithm**: set the layout algorithm to apply after the rule application.

Here is the description of the dialog interface:

- **Restore System Default**: get the default parameters. Replace current parameters.
- **Set as Defaults**: save the current parameters as default.
- **Cancel**: cancel the rule application.
- **OK**: launch the rule application process.

If the process works, the result model will appear in the trace graph, else a red square will appear.

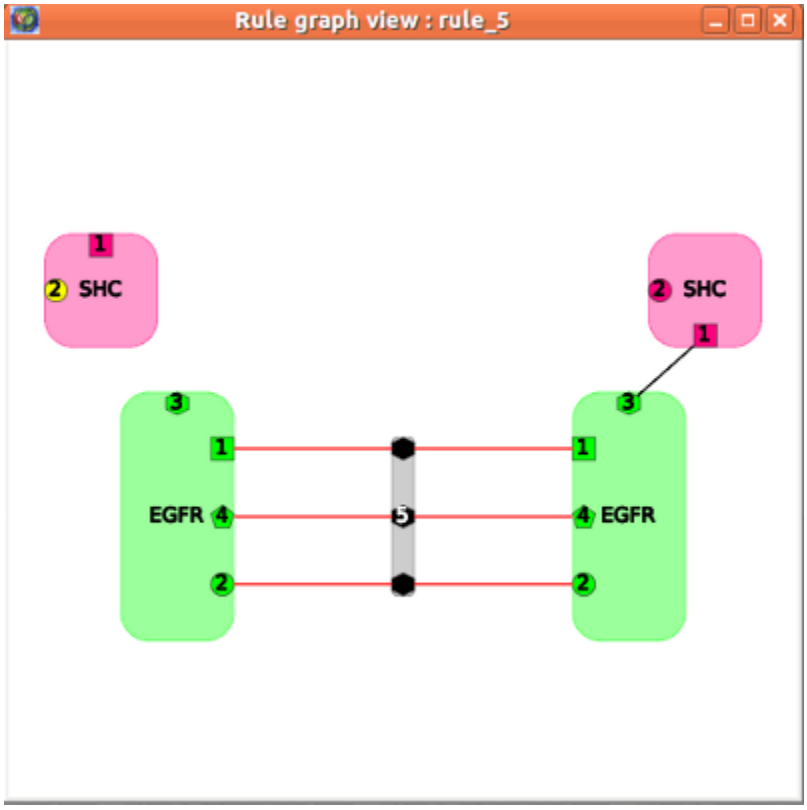
1.7.3 Rule View

This is the visualization/edition view for rules.

Contextual menu

Right-click (**Ctrl**-click Mac) to display this menu:

- **Options**
  - **Center view** : move the camera the visualize all the models in the trace.



– **Redraw** : redraw the trace and center the view.

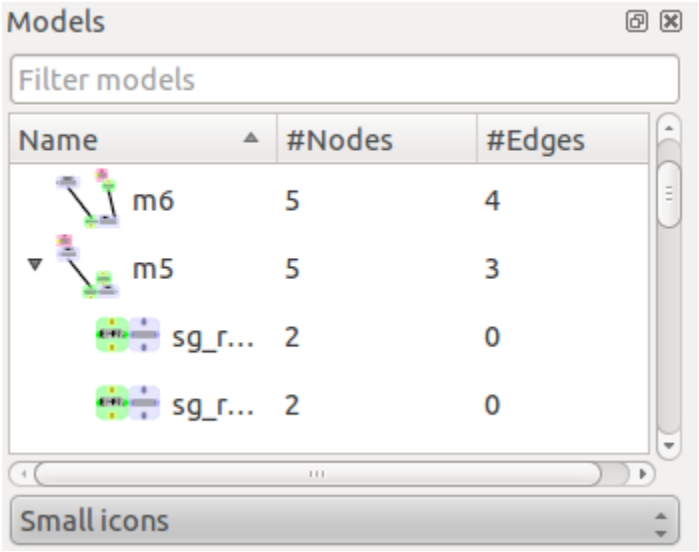
Interaction tools

- **Navigation**: move, rotate and zoom the view. Zooming behavior: the point under the cursor is moved closer to the center.
- **Get information**: click an element (portnode or edge) and Porgy displays all available properties of that element in the properties widget.
- **Rectangle selection**: select all elements touching the selection box (the previous selection is replaced, but can be recovered with Undo). With Shift, the newly selected elements are added to the current selection; with Ctrl (Alt on Mac), the selected elements are removed from the current selection.
- **Selection edition**: modify the shape and position. Shift-click modifies only coordinates. Ctrl-click modifies only size. Left-click outside the selection resets the selection.
- **Edit edge bends**: click on an edge to select it (with this tool), then Shift-click to add a new bend, click a bend to move it, or Ctrl-click (Alt on Mac) to remove a bend.
- **Add port nodes**: allow the user to create,edit and add portnodes.
- **Add edge: to add an edge, click the source node, optionally click outside of nodes to add bends, finally click the targe**

You can only add edge between two ports.

- **Delete element**: click a portnode or edge to delete it.

1.8 Editing Models



Click on **Models** tab to access to the Models management widget. Use the text line at the top of the widget to filter models using names.

There is four preview mode :

- **No icons**: Do not display previews.
- **Small icons**
- **Medium icons**
- **Large icons**

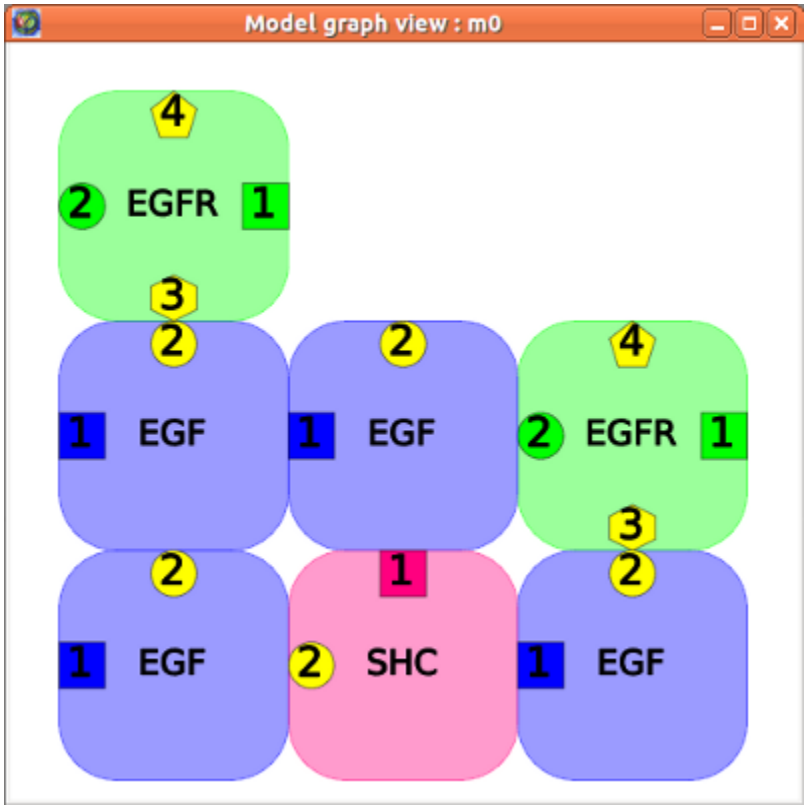
To display a larger preview of the model hover it. You can display a visualization/edition view for a model by double clicking on it or by dragging it and dropping it on the workspace.

1.8.1 Model View

This is the visualization/edition view for models.

Configuration

- **Labels**
  - **Nodes labels**: toggle the portnodes and ports label.



Contextual menu

Right-click (**Ctrl**-click Mac) to display this menu:

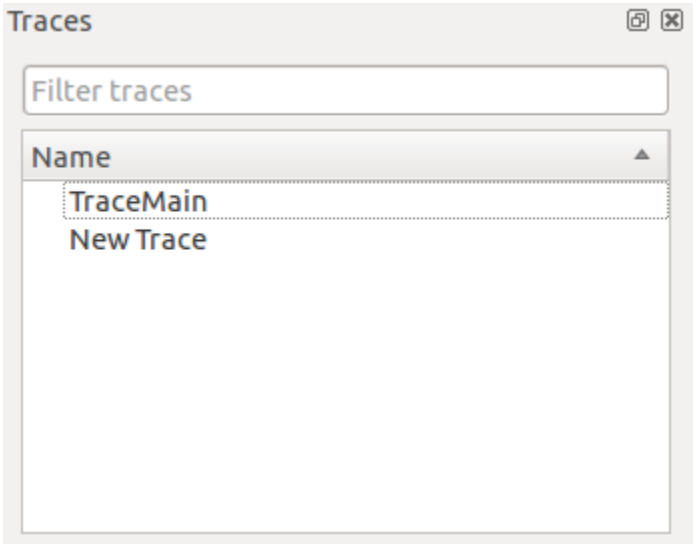
- **Options**
  - **Center view** : move the camera the visualize all the models in the trace.
  - **Redraw** : redraw the trace and center the view. You can choose between a force drawing algorithm (GEM (Frick)) or a hierarchical drawing algorithm (Sugiyama (OGDF))

Interaction tools

- **Navigation**: move, rotate and zoom the view. Zooming behavior: the point under the cursor is moved closer to the center.
- **Get information**: click an element (portnode or edge) and Porgy displays all available properties of that element.
- **Rectangle selection**: select all elements touching the selection box (the previous selection is replaced, but can be recovered with Undo). With Shift, the newly selected elements are added to the current selection; with Ctrl (Alt on Mac), the selected elements are removed from the current selection.
- **Selection edition**: modify the shape and position. Shift-click modifies only coordinates. Ctrl-click modifies only size. Left-click outside the selection resets the selection.

- **Edit edge bends**: click on an edge to select it (with this tool), then Shift-click to add a new bend, click a bend to move it, or Ctrl-click (Alt on Mac) to remove a bend.
- **Add port nodes**: allow the user to create,edit and add portnodes.
- **Add edge: to add an edge, click the source node, optionally click outside of nodes to add bends, finally click the targe** You can only add edge between two ports.
- **Delete element**: click a portnode or edge to delete it.

1.9 Editing Traces



Click on **Traces** tab to access to the Traces management widget. Use the text line at the top of the widget to filter traces using names. You can display a visualization/edition view for a trace by double clicking on it or by dragging it and dropping it on the workspace. There is 4 kind of visualizations for trace graphs (see the views section for more information on Porgy views).

- **Trace graph view**: This is the general visualization for trace graphs.
- **Scatter plot 2D view**
- **Histogram view**
- **Small multiple view**

To rename a trace select it and click with the left button on the it's name. Input the new name then press return to validate the new name. If you press the escape button the edition will be canceled.

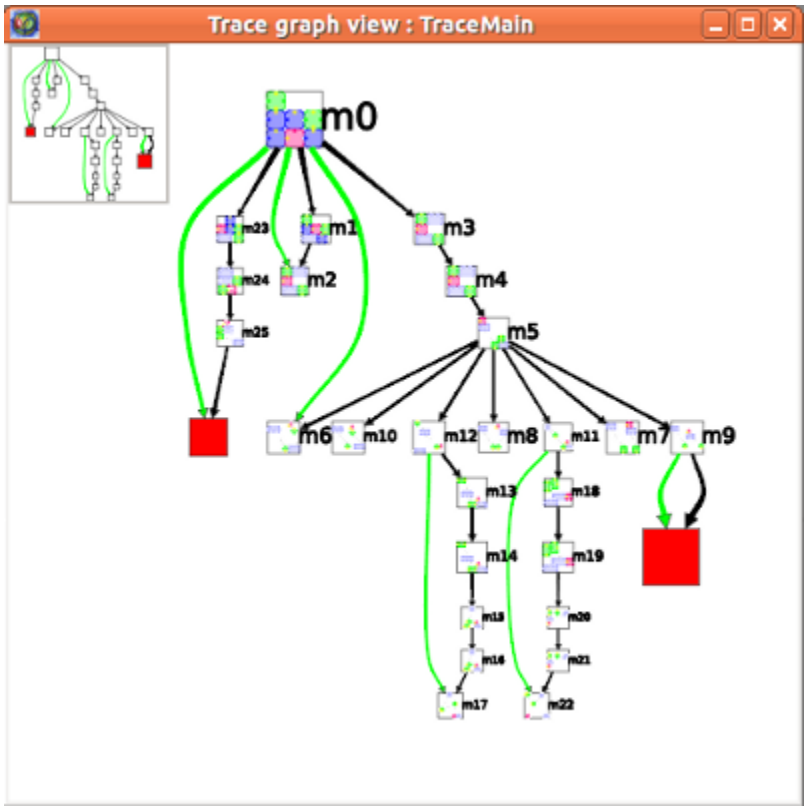
1.9.1 Contextual menu

- **Show** : Create a visualization/edition view on the workspace. One can also double click on the rule or drag and drop the trace on the workspace to display it.
- **Create new** : Create a new trace based on the models selected in the main trace graph.

- **Delete** :Destruct the selected trace. One cannot delete the main trace.

1.9.2 Trace View

This is the base view for trace graphs. Displays the models present in the graph as a hierarchy of models. Each edge between two models represents the transformation of the source model to the destination model. A transformation can be an application of a rule (simple rule), an application of a strategy or a modification of the p property (Set position).



Contextual menu

Right-click (**Ctrl**-click Mac) to display this menu:

- **Options**
  - **Center view** : move the camera the visualize all the models in the trace.
  - **Redraw** : redraw the trace and center the view.
- **Dialog**
  - **3D Overview**: toggle top left overview

If a model is present under the cursor some other options are available:

- **Open in a new model view** : show the model under the pointer in a new view.
- **Add to/Remove from the selection** : if the model is present in the current selection remove it else add it.

Interaction tools

- **Navigation**: move, rotate and zoom the view. Zooming behavior: the point under the cursor is moved closer to the center.
- **Get information: click an element (portnode or edge) and Porgy displays all available properties of that element.** If you hoover an edge it will display the transformation information as a tool tip and it will highlight portnodes involved in this transformation. Here is the color code used when higlighting portnodes involved in a transformation: * Simple rule : LHS portnodes are in red and RHS are in blue. * Set position : portnodes that are only in the original P property are in red, portnodes only in the new P property are in blue and portnodes in both old and new are in green.
- **Rectangle selection**: select all elements touching the selection box (the previous selection is replaced, but can be recovered with Undo). With Shift, the newly selected elements are added to the current selection; with Ctrl (Alt on Mac), the selected elements are removed from the current selection.
- **Zoom box**: draw a rectangle and zooms on this area.
- **Open in a new model view** : click on a model and it will be displayed a new view.
- **Selection edition**: modify the shape and position. Shift-click modifies only coordinates. Ctrl-click modifies only size. Left-click outside the selection resets the selection.
- **Edit edge bends**: click on an edge to select it (with this tool), then Shift-click to add a new bend, click a bend to move it, or Ctrl-click (Alt on Mac) to remove a bend.

Configuration

- **Labels**
  - **Nodes labels**: displays the models names.
  - **Meta-node labels**: displays the names of the portnodes inside each models. This option can slow down the application.

1.9.3 Scatter plot 2D View

This view allows to create 2d scatter plots of graph nodes from graph properties (supported types are Metric and Integer). A scatter plot is a type of mathematical diagram using Cartesian coordinates to display values for two variables for a set of data. The data is displayed as a collection of points, each having the value of one variable determining the position on the horizontal axis and the value of the other variable determining the position on the vertical axis.

By selecting a set of graph properties, a scatter plot matrix will be displayed for each combination of two different properties. Each scatter plot can then be displayed individually in a more detailed way.

A set of interaction tools are bundled with the view to perform selection, statistical analysis, ...

1.9.4 Histogram view

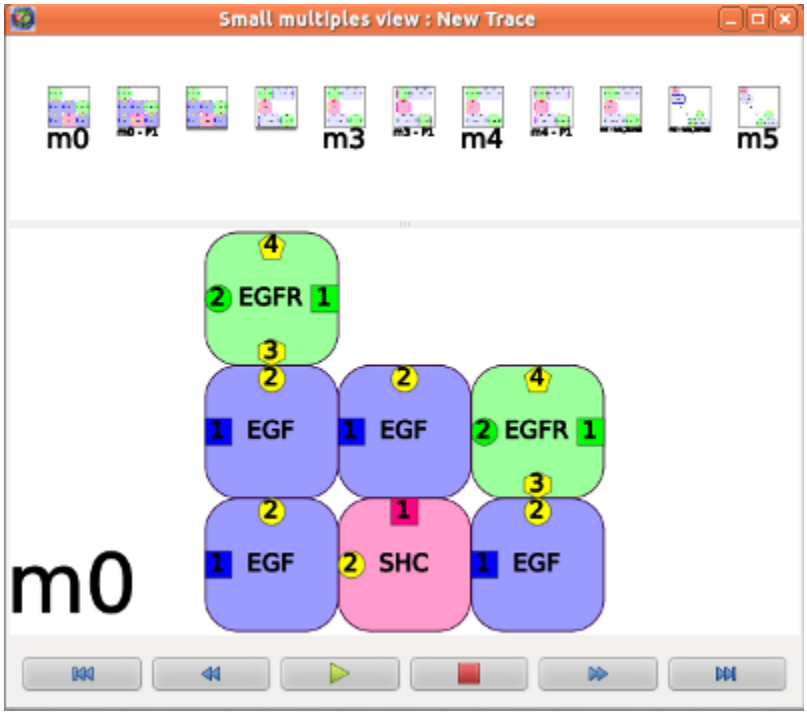
This view plug-in allows to create frequency histograms from graph properties (supported types are Metric and Integer). By selecting a set of graph properties, frequency histograms are computed and displayed for values associated to nodes (or edges).

This view also allows to map visual properties (colors, sizes, glyphs, ..) of the graph elements with respect to a graph metric in a visual way. These operations can be done with the "Metric mapping" interactor. Many interaction tools are also bundled with the view to perform elements selection, statistical analysis, ...

1.9.5 Small multiple View

This view allows to visualize the transformations between different models using small multiples and/or animation. User can add intermediate states to emphasize elements present in the P property, the LHS and the RHS.

Small multiples are useful to have an overview of the whole states of the trace graph. The aim of the animation is to interpolate the change each states to show a video of the change. You see the *film* of the transformations.



Configuration

General

- **Intermediate states** [compute intermediate states between two models.]
  - **RHS** : elements in the right hand side have their border highlighted in red.
  - **LHS** : elements in the left hand side have their border highlighted in blue.
  - **P** : elements in the P property have their border highlighted in pink.
- **Widgets**

  - Small multiples
  - Animation

Animation

- **Animation duration** : the duration of the animation between two states.
- **Nodes labels** : displays the labels of portnodes in the animation

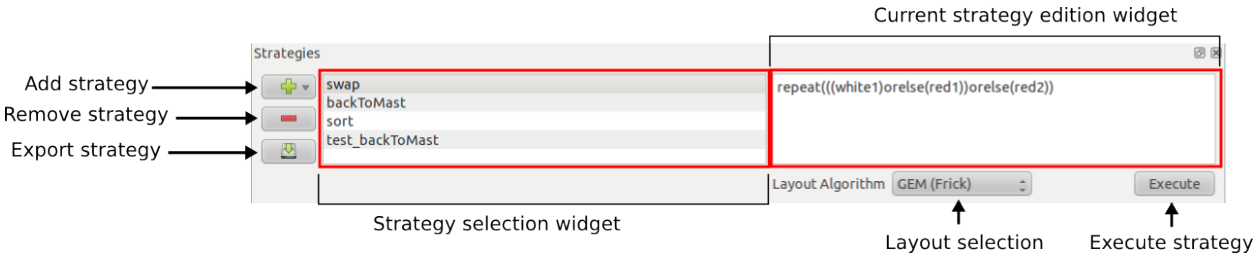
Small multiples

- **Small multiples layout**
  - **Automatic** : computes automatically the number of lines in function of the number of pictures.
  - **Force number of lines** : force the number of lines.

1.10 Editing Strategies

1.10.1 Strategies management

This widget handle all the strategies management actions.



- **Add strategy :**
  - **Create an empty strategy**
  - **Compute a strategy from selected models** : try to compute the strategy from the selected models elements in the main trace.
  - **Import from a file** : load a strategy from a file. The new strategy will have the name of the file loaded without the file extension.
- **Remove strategy**: remove the selected strategy
- **Export strategy** : save the selected property on the disk.

1.10.2 Applying a strategy

The application of a strategy can be made with 2 different way:

- Drag and drop a strategy to:
  - a model metanode in the trace view. If the operation is valid a green square will appear on the model.

  - a model view.

- Select a strategy, select a model in the models widget and press on the **Execute** button.

1.10.3 Strategies edition

When selecting a strategy in the strategy management widget it's code appear in the edition widget.

Strategies macro system

You can call an existing strategy inside another strategy. Just insert the name of the strategy to insert surrounded by # in a strategy. By example we have two strategies:

`Strategy_1`
rule_1;rule_2

`Strategy_2`
rule_3;rule_4

We want to create a new strategy that uses the strategy 1 and the strategy 2

`Strategy_3`
rule_5;#Strategy_1#;rule_7;#Strategy_2#;rule_10

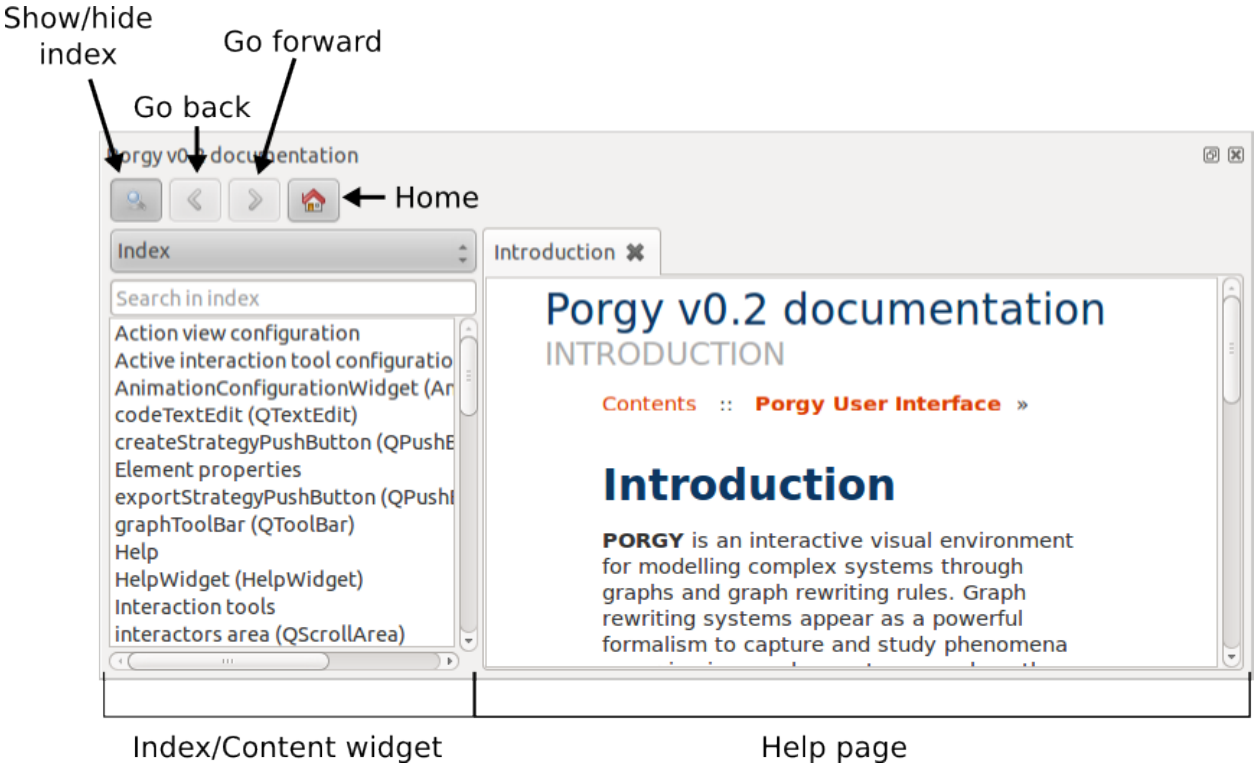
Editing Key Bindings

To select (mark) text hold down the Shift key whilst pressing one of the movement keystrokes, for example, Shift+Right will select the character to the right, and Shift+Ctrl+Right will select the word to the right, etc. The list of key bindings which are implemented for editing:

Keypresses	Action
Backspace	Deletes the character to the left of the cursor.
Delete	Deletes the character to the right of the cursor.
Ctrl+C	Copy the selected text to the clipboard.
Ctrl+Insert	Copy the selected text to the clipboard.
Ctrl+K	Deletes to the end of the line.
Ctrl+V	Pastes the clipboard text into text edit.
Shift+Insert	Pastes the clipboard text into text edit.
Ctrl+X	Deletes the selected text and copies it to the clipboard.
Shift+Delete	Deletes the selected text and copies it to the clipboard.
Ctrl+Z	Undoes the last operation.
Ctrl+Y	Redoes the last operation.
Left	Moves the cursor one character to the left.
Ctrl+Left	Moves the cursor one word to the left.
Right	Moves the cursor one character to the right.
Ctrl+Right	Moves the cursor one word to the right.
Up	Moves the cursor one line up.
Down	Moves the cursor one line down.
PageUp	Moves the cursor one page up.
PageDown	Moves the cursor one page down.
Home	Moves the cursor to the beginning of the line.
Ctrl+Home	Moves the cursor to the beginning of the text.
End	Moves the cursor to the end of the line.
Ctrl+End	Moves the cursor to the end of the text.
Alt+Wheel	Scrolls the page horizontally (the Wheel is the mouse wheel).

1.11 Help widget

This widget will help you to use **Porgy** perspective. Click on a link in the main widget to navigate in the user manual. You can navigate in the history any time using the **Previous** and **Next** buttons. To go directly to the contents page use the **Home** button.



By pressing the search button (the top-left one) it will display the index/content panel that will help you to navigate through the user manual. Double click on an item to show the corresponding page in a new tab.

CHAPTER

TWO

PORGY DATA STRUCTURE

The **Porgy** structure is made of these elements :

- **Portgraph**: a common base structure for models and rules. Contains Portnodes and edges.
  - **Model**: a state of the model.
  - **Rule**: a transformation rule.
- **Trace**: a derivation tree which keeps a trace of each rewrite operation.

2.1 Portgraphs

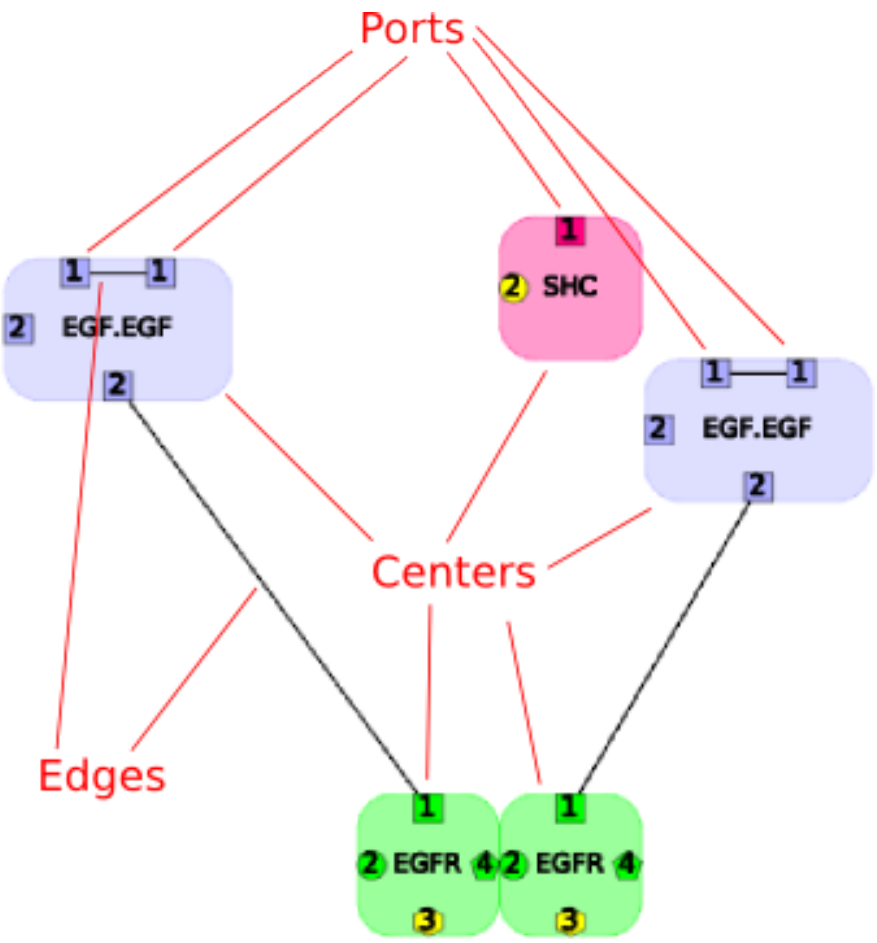
Portgraphs are the common ancestors for Rules and models. They are made of portnodes and edges which link the portnodes via the ports. In practical terms a portnode is made of nodes and edges. A first node is the center of the portnode. The nodes connected to the center node are the ports. The connections between portnodes can only be done through ports.

The properties detailed below must be used in order to identify each part of a portnode:

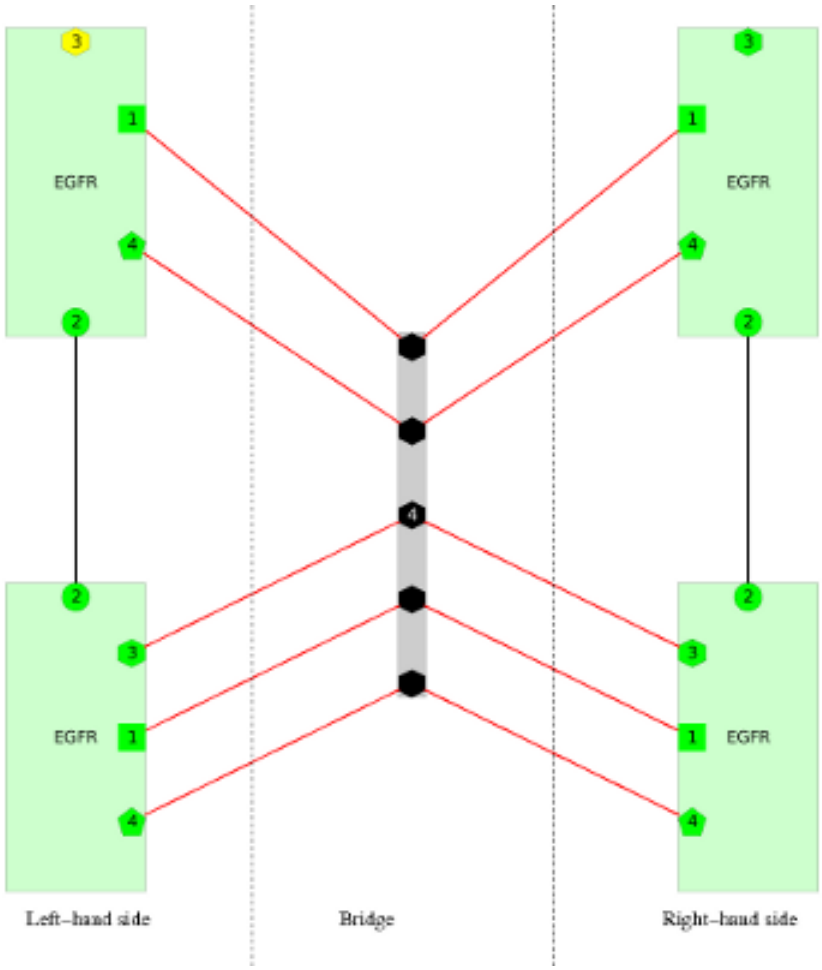
- **PortNode_type**: type of the node. Two possible values: center or port.
- **State**: define a particular state of the port. The possible values depend on the data used and can also be different between rules and models:
  - **hidden**: the port cannot be connected to another one (for biochemical networks).
  - **used**: the port is connected to another one. This property can be used along with the property called "arity" (see below).
  - **free**: the port can be connected to another one (for biochemical networks).
  - **not used** (only for rules): the state and arity of the port are not taken into account by the matching algorithm for the application of a rule.
  - **Principal** : the port is the principal port of the agent (for interaction nets).

2.2 Rules

A rule is composed of a left-hand side, a right hand-side and a bridge which connects both sides. The red edges represent connections of equivalent ports between the left-hand side and the right-hand side. For instance, the two ports labeled "4" in both EGFR portnodes on the left-hand side are connected to the ports also labeled "4" in the right-hand side. These specific edges allow to restore the state of the node and its connections after rewriting (used


Ports
1
1
2
EGF.EGF
2
1
2
SHC
1
1
2
EGF.EGF
2
Centers
Edges
1
2
EGFR
4
3
1
2
EGFR
4
3

mostly for ports in the "not used " state or with an arity greater than zero). All connections between the left-hand side and the right-hand side must go through a port of the bridge.



Some additional properties are required to define a rule:

- **Arity**: Arity of a port in the left-hand side of the rule. Sometimes a port needs to be connected to some other ports in the model which are not part of the left-hand side of the rule. This property is used to indicate the number of connections.
- **Rule_side**: For each component (nodes and edges), identify the part of the rule. There are four possible values: left, right, bridge and bridge_port. The value "bridge" is used to indicate which node is the center of the bridge. It is also used for the edges on either side of the bridge. The value "bridge_port" is used to identify the ports of the bridge.
- **saveId**: Only useful on the right-hand side. Used to save the initial Tulip id of nodes and edges before rewriting. This property needs to be set before applying the rewrite algorithm.
- **M**: if an element of the right-hand side of the rule has its M property set to true, then it is added to the current P position of the newly generated model during rewriting.

2.3 Models

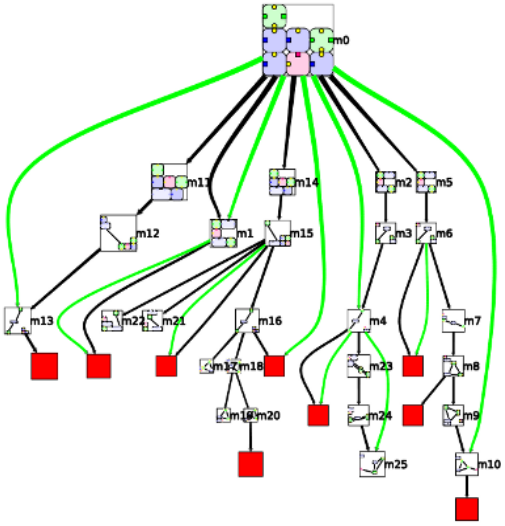
The models have some additional properties to keep a trace of each transformation: * **new**: Boolean property set to true if the edge or the portnode is new, i.e. it has been created or modified by the last transformation.

The subgraphs of each models which represent the instantiation of the left-hand side of a rule, use some specific properties:

- **tag**: Tulip id of the corresponding node or edge in the left-hand side of the rule.
- **P**: This property is used to define a subgraph of a model m. This subgraph can be used to restrict the search of the instances of the left-hand rl side of a rule r in a model m. When one tries to find the instances I of rl in m, at least one node of each I must be in P. It is possible to define more than one P.

2.4 Traces

The nodes of the derivation tree are metanodes associated to each generated models. There is a black edge between two metanodes a and b if the application of a rule transforms a source model a into a destination model b. The label of the metanodes (on the left side of each node) is the name of the model. The result of a strategy is represented by a green edge between the source model and the results of the strategy.



If the result of the application of a rule or a strategy is a red node the rule or the strategy application ends on a failure.

CHAPTER

THREE

BUILDING THE DERIVATION TREE

In **Porgy** there is two way to build a derivation tree:

- Applying rules
- Applying strategy

3.1 Applying rules

The application of a rule to a given model consists in two phases: find at least one instance of the left-hand side of the rule inside the model, then replace this instance by the right-hand side of the rule. Each instance of the left hand-side is computed as a subgraph of the corresponding model.

3.2 Strategies

A strategy is a small script language created to improve the rule rewriting possibilities.

3.2.1 Grammar

3.2.2 Strategy operators